DESCRIPTION

Demonstration Circuit 616 is a synchronous, 4-phase boost converter using the LTC3425. It is capable of operating below 1V input. DC616A is set for 3.3V output. DC616B is set for 5V output. On each demo board, the left circuit gives higher efficiency and current rating; while the right circuit has smaller size and lower cost.

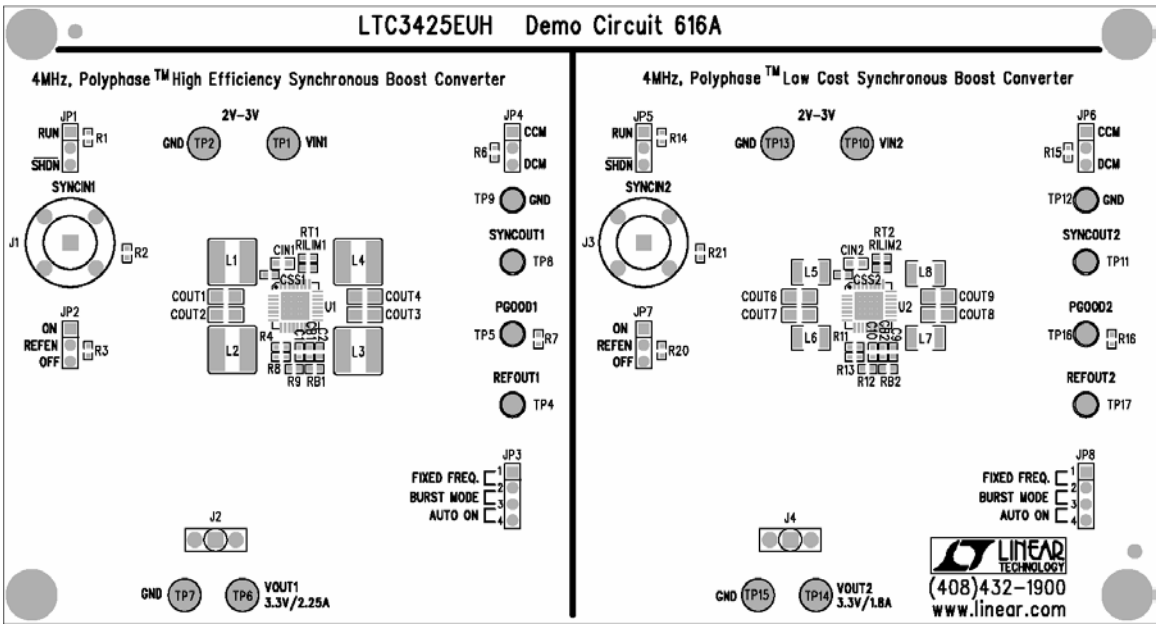
The switching frequency is set at 1MHz per phase, minimizing inductor and capacitor size. A single resistor at RT pin sets the frequency. If desired, the LTC3425 can be synchronized to an external clock.

Long wires run from input sources (such as wall adaptors) can cause large voltage spikes during initial plug-in. C5 and C15 are installed on DC616 to damp the possible voltage spikes. They are not required for applications where input source is close to the regulator. Please refer to Application Note 88 for details.

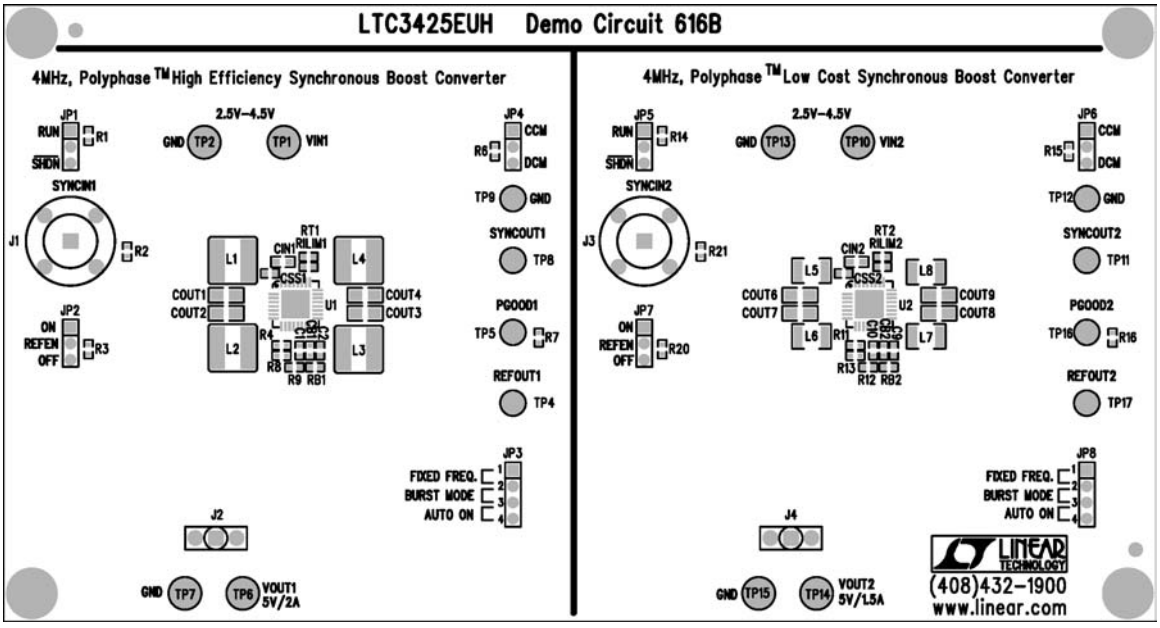
Design files for this circuit board are available. Call the LTC factory.

Table 1. DC616A Performance Summary (T_A = 25°C unless otherwise noted)

PARAMETER	CONDITION	VALUE
Minimum Input Voltage (Start-Up)		1V
Output Voltage V_{OUT1} (High Efficiency Circuit)	V_{IN} = 2V to 3V, I_{OUT1} = 0A to 2.25A	3.3V ±4%
Output Voltage V_{OUT2} (Low Cost Circuit)	V_{IN} = 2V to 3V, I_{OUT2} = 0A to 1.8A	3.3V ±4%
Maximum Output Current (High Efficiency Circuit)	V_{IN} = 2V to 3V	2.25A
Maximum Output Current (Low Cost Circuit)	V_{IN} = 2V to 3V	1.8A
Typical Output Ripple V_{OUT}	V_{IN} = 2.4V, I_{OUT} = 1.8A (20MHz BW)	28mV_{P-P}
Typical Switching Frequency (each phase)		1MHz
Efficiency (High Efficiency Circuit)	V_{IN} = 2.4V, I_{OUT1} = 0.5A	93.0% Typical
	V_{IN} = 2.4V, I_{OUT1} = 2A	88.6% Typical
On/Off Control	Logic Low Voltage-Off, -40°C to 85°C	0.25V MAX
	Logic High Voltage-On (Initial Start-Up), -40°C to 85°C	1V MIN
	Logic High Voltage-On (V_{OUT}>2.4V), -40°C to 85°C	0.65V MIN



Demo Circuit 616A = 3.3Vout@2.25A or 1.8A



Demo Circuit 616B = 5Vout@2.0A or 1.5A

Table 2. DC616B Performance Summary (T_A = 25°C unless otherwise noted)

PARAMETER	CONDITION	VALUE
Minimum Input Voltage (Start-Up)		1V
Output Voltage V_{OUT1} (High Efficiency Circuit)	V_{IN} = 2.5V to 4.5V, I_{OUT1} = 0A to 2A	5V ±4%
Output Voltage V_{OUT2} (Low Cost Circuit)	V_{IN} = 2.5V to 4.5V, I_{OUT2} = 0A to 1.5A	5V ±4%
Maximum Output Current (High Efficiency Circuit)	V_{IN} = 2.5V to 4.5V	2A
Maximum Output Current (Low Cost Circuit)	V_{IN} = 2.5V to 4.5V	1.5A
Typical Output Ripple V_{OUT}	V_{IN} = 3.3V, I_{OUT} = 1.5A (20MHz BW)	33mV_{P-P}
Typical Switching Frequency (each phase)		1MHz
Efficiency (High Efficiency Circuit)	V_{IN} = 3.3V, I_{OUT1} = 0.5A	93.0% Typical
	V_{IN} = 3.3V, I_{OUT1} = 2A	92.3% Typical
On/Off Control	Logic Low Voltage-Off, -40°C to 85°C	0.25V MAX
	Logic High Voltage-On (Initial Start-Up), -40°C to 85°C	1V MIN
	Logic High Voltage-On (V_{OUT}>2.4V), -40°C to 85°C	0.65V MIN

QUICK START PROCEDURE

Demonstration circuit 616 is easy to set up to evaluate the performance of the LTC3425. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the Vin or Vout and GND terminals. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

JP1, JP5 RUN

JP2, JP7 ON

JP4, JP6 DCM

JP3, JP8 AUTO ON.

2. With power off, connect the input power supply to VIN1 and GND or VIN2 and GND.
3. Turn on the power at the input.

   NOTE: Make sure that the input voltage does not exceed 4.5V.
4. Check for the proper output voltage.
5. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
6. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.
7. Different operating modes can be selected according to the following table:

8. The active clamping circuits are installed on DC616B to prevent the voltages at switch nodes from exceeding the maximum rating (refer to data sheet "Applications Where Vout > 4.3V" section for details). If there is any momentary short-circuit condition, please add a 5Ω resistor in series with Q1.

Table 3. LTC3425 Operating Modes

OPERATING MODE	JP3, JP8 POSITION	JP4, JP6 POSITION
Forced Burst	BURST MODE	DCM
Automatic Burst (Operating Mode is Load Dependent)	AUTO ON	DCM
Forced Fixed Frequency with Pulse Skipping at light load	FIXED FREQ	DCM
Forced Fixed Frequency, Low Noise (No Pulse Skipping)	FIXED FREQ	CCM

GRAPHIC

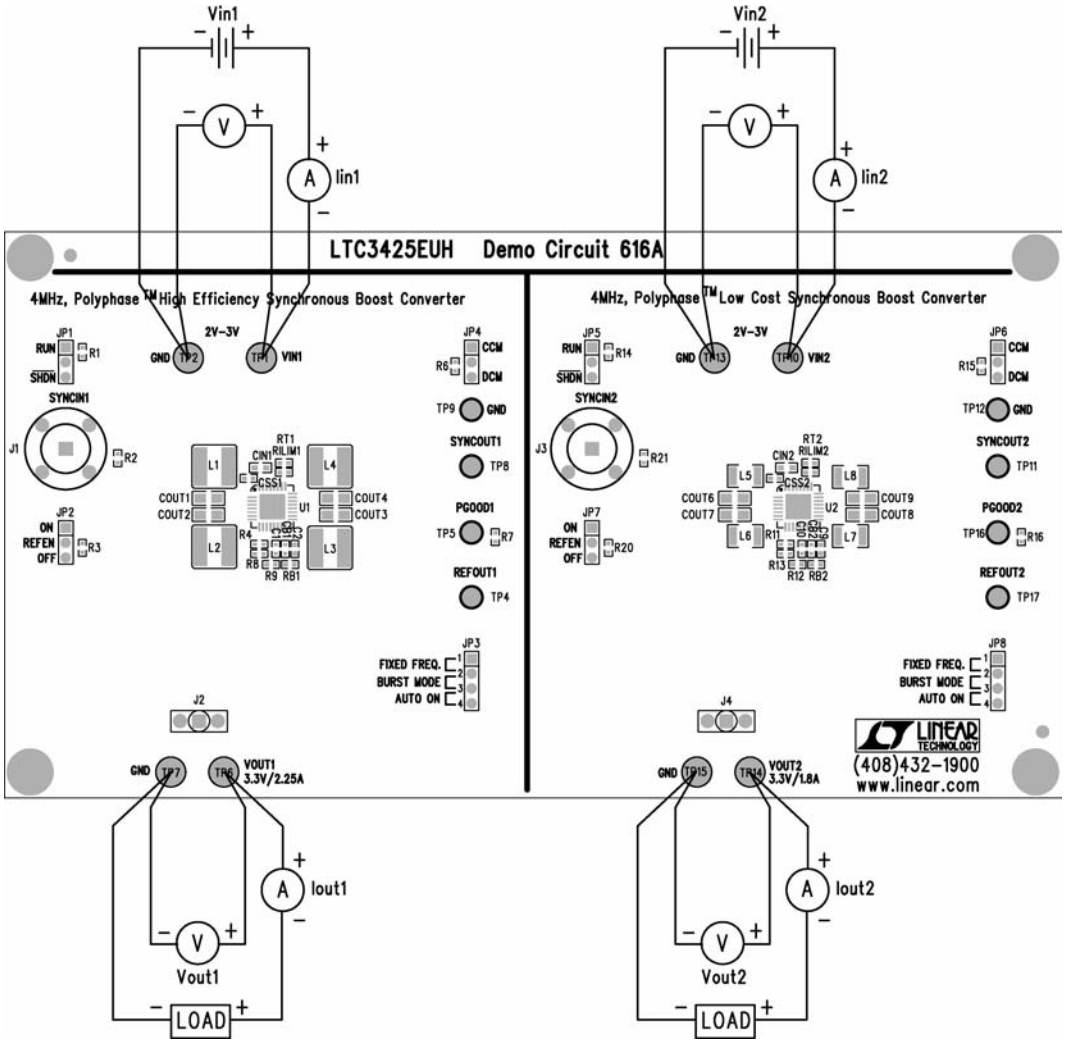


Figure 1. Proper Measurement Equipment Setup

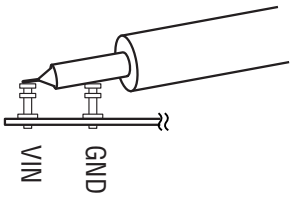


Figure 2. Measuring Input or Output Ripple

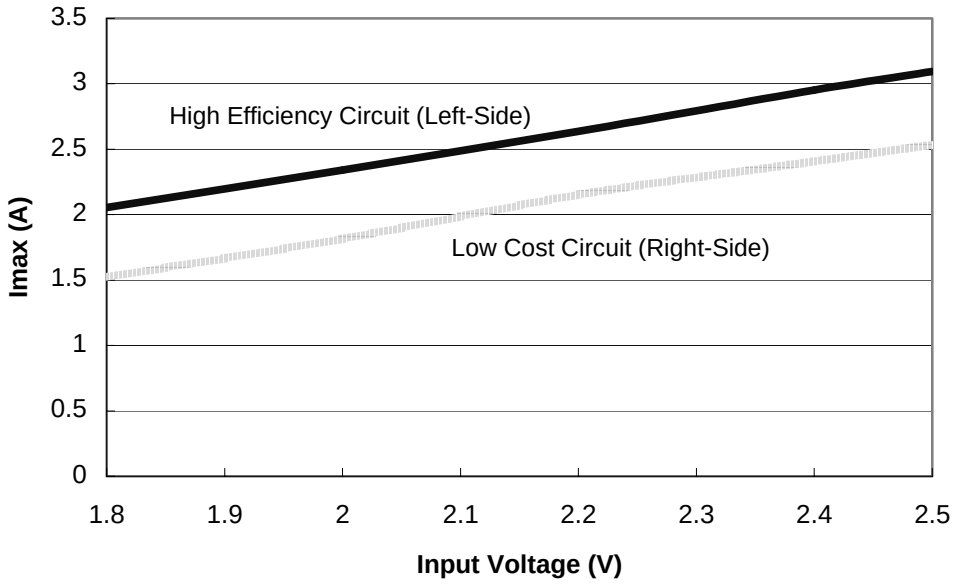


Figure 3. Maximum Output Current vs Input Voltage for 3.3V Output (DC616A)

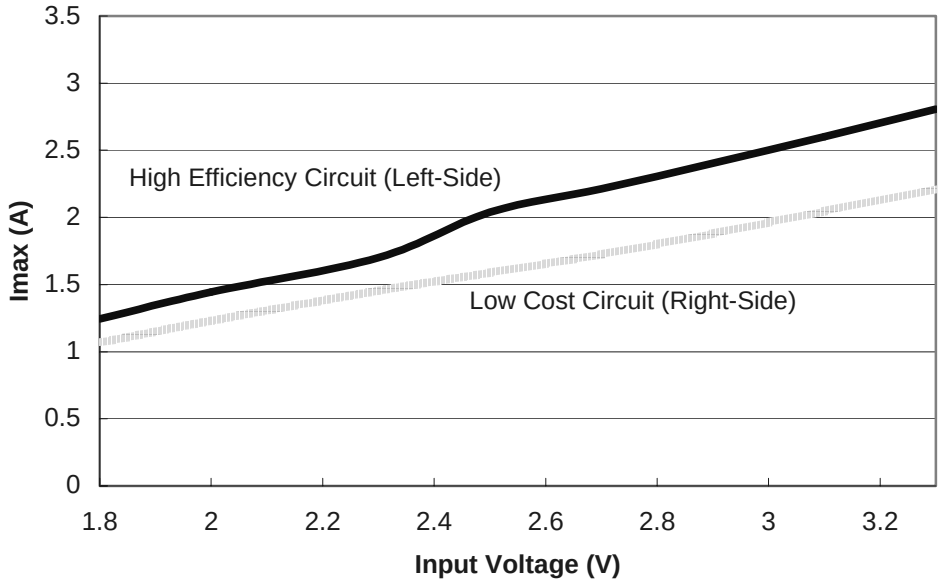


Figure 4. Maximum Output Current vs Input Voltage for 5V Output (DC616B)

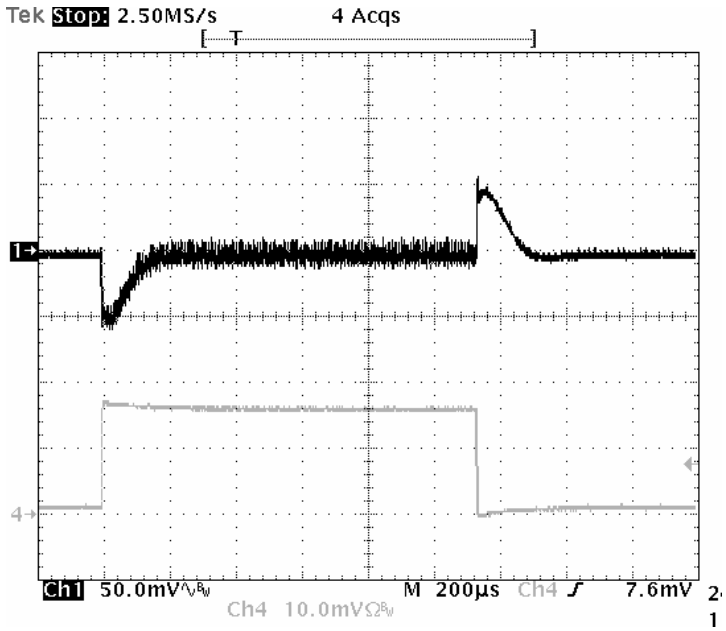


Figure 5. DC616A Load Transient Response (Vin=2.4V;Channel 1: Vout1; Channel 2: Iout: load step from 0.2A to 2.25A)

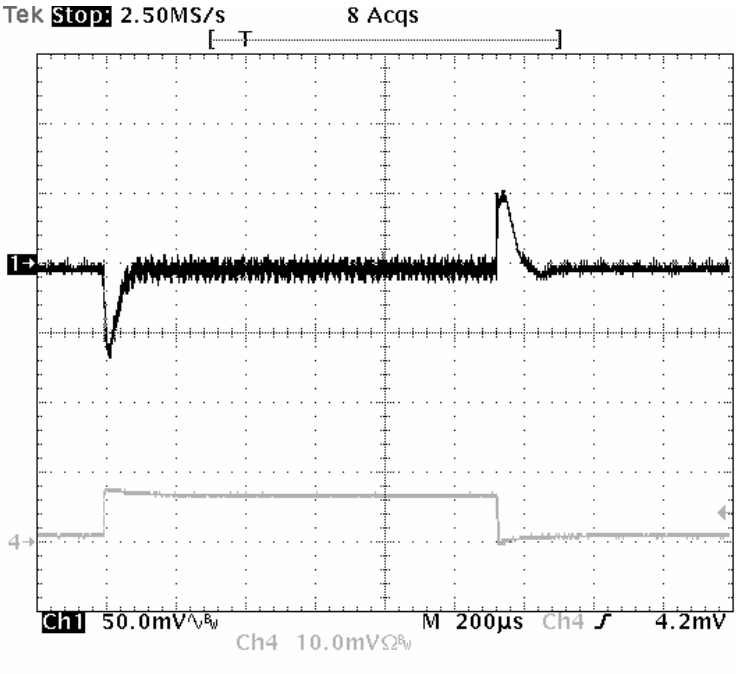
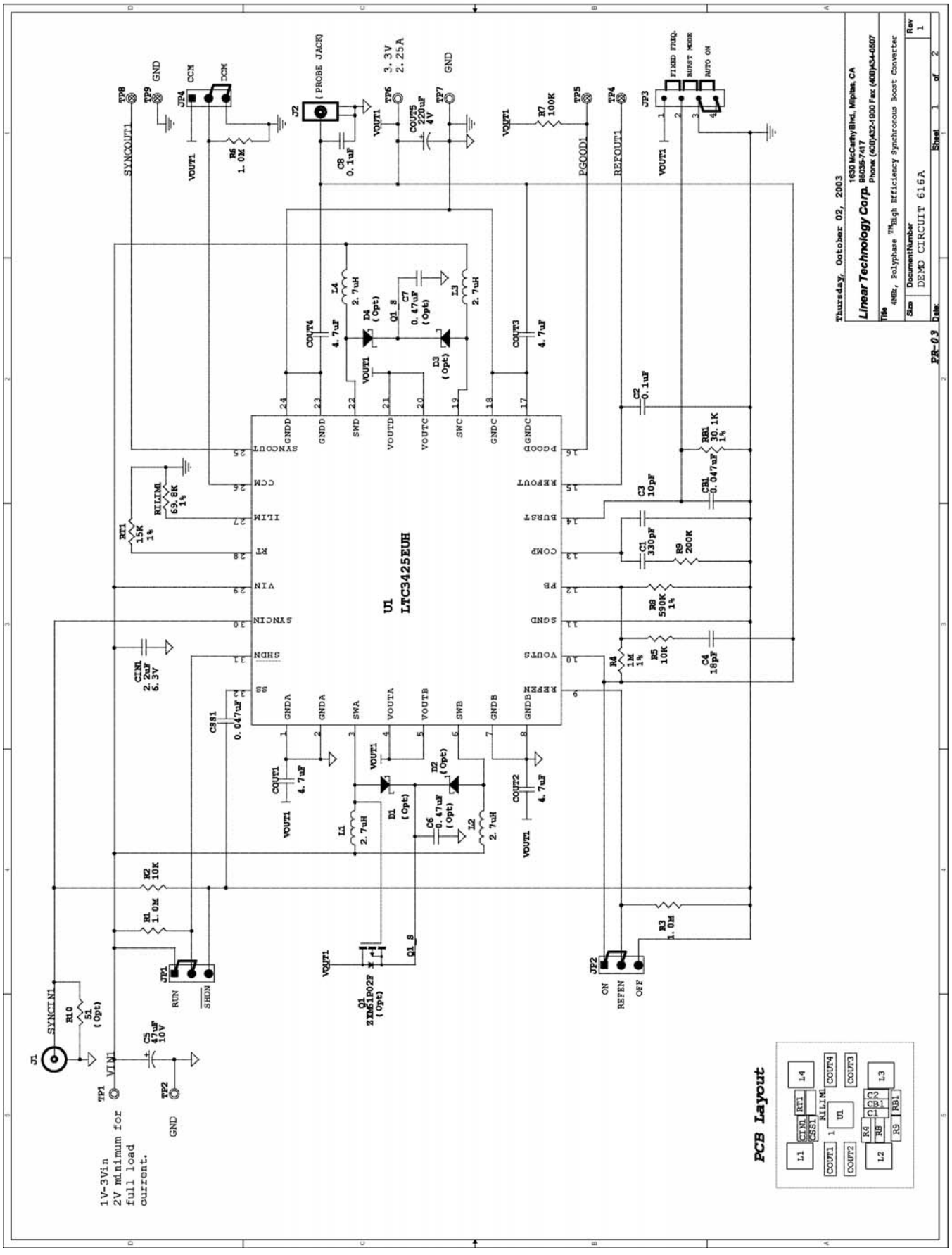


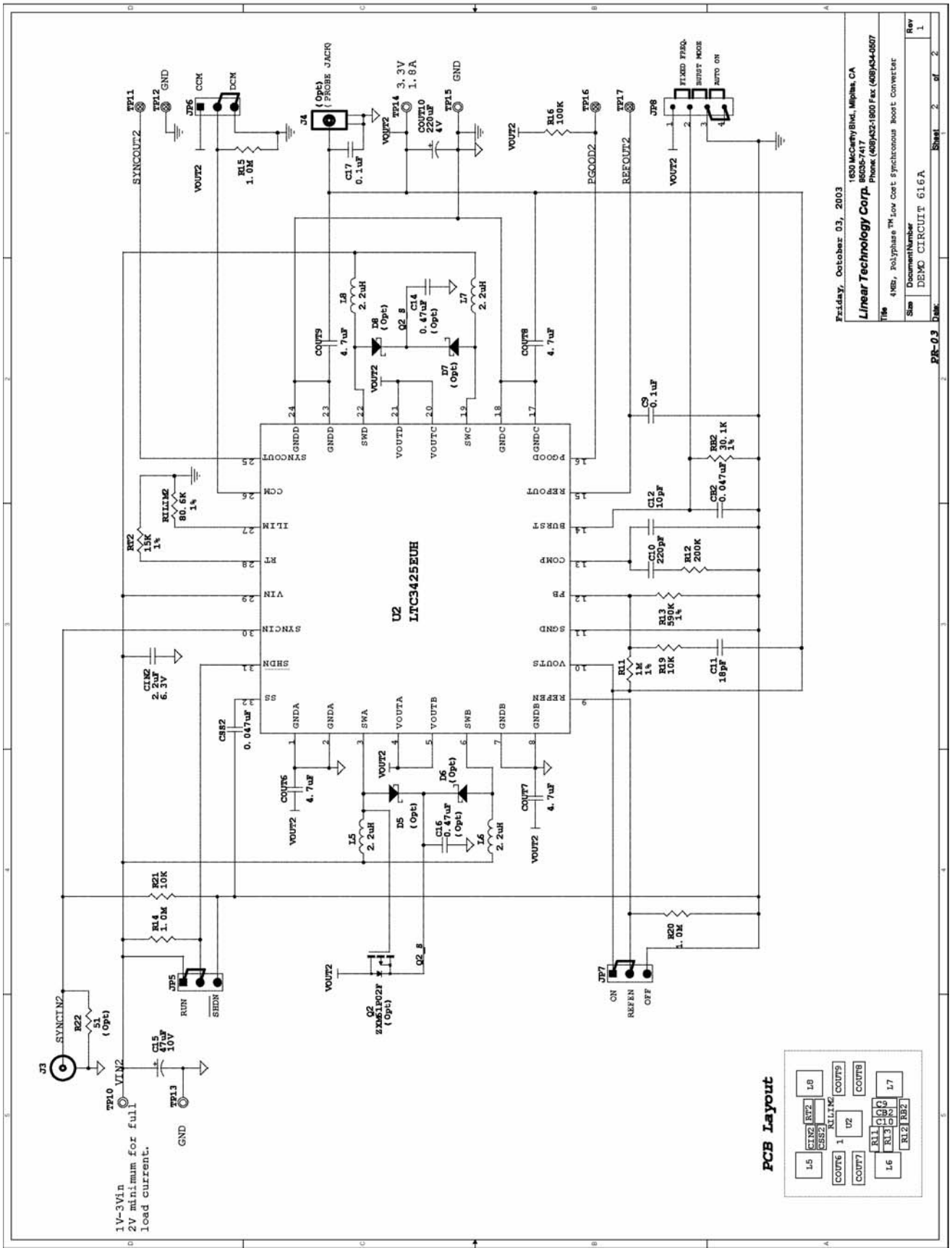
Figure 6. DC616B Load Transient Response (Vin=4.2V;Channel 1: Vout1; Channel 2: Iout1: load step from 0.2A to 2A)


U1
LTC3425EUH
Linear Technology Corp.
1630 McCarthy Blvd., Milpitas, CA
Phone (408)432-1900 Fax (408)434-0507
4MHz, Polyphase TM High Efficiency Synchronous Boost Converter
DEMO CIRCUIT 616A
Thursday, October 02, 2003
PCB Layout
1V-3Vin
2V minimum for
full load
current.

Vin=1V to 3V

Vout=3.3V@2.25A

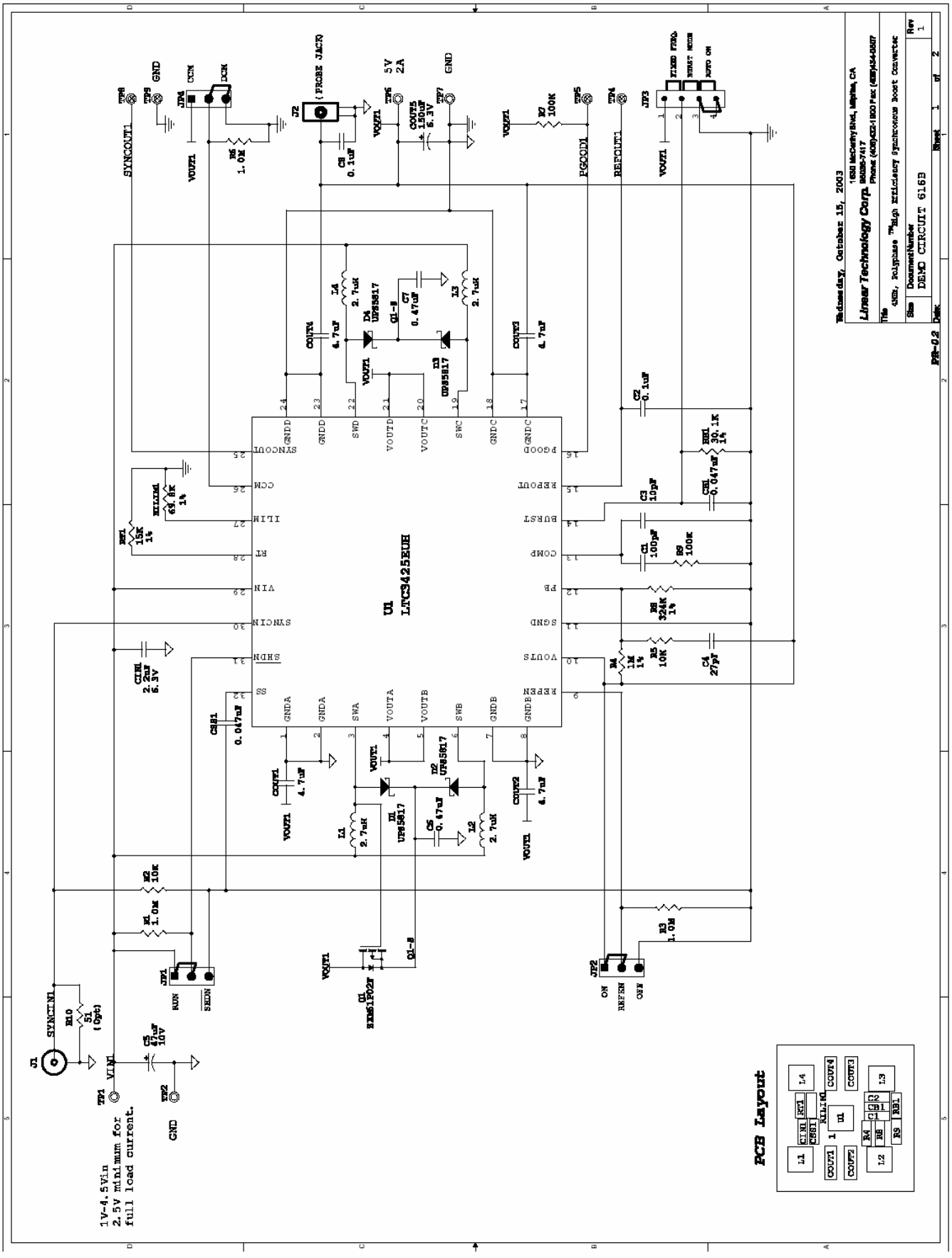
Item	Quantity	Reference	Part	
1	2	CB1,CSS1	Cap., X5R 0.047uF 16V 20%	AVX 0402YD473MAT2A
2	1	CIN1	Cap., X5R 2.2uF 6.3V 10%	Taiyo Yuden JMK107BJ225KA-T
3	4	COUT1,COUT2,COUT3,COUT4	Cap., X5R 4.7uF 6.3V 20%	Taiyo Yuden JMK212BJ475MG-T
4	1	COUT5	Cap., POSCAP 220uF 4V 20%	SANYO 4TPC220M
5	1	C1	Cap., NPO 330pF 25V 10%	AVX 04023A331KAT2A
6	2	C2,C8	Cap., X5R 0.1uF 10V 10%	TDK C1005X5R1A104K
7	1	C3	Cap., NPO 10pF 25V 10%	AVX 04023A100KAT2A
8	1	C4	Cap., NPO 18pF 25V 10%	AVX 04023A180KAT2A
9	1	C5	Cap., Tant. 47uF 10V 20%	AVX TAJB476M010
10	0	C6,C7 (Opt)	Cap., X5R 0.47uF 10V 10%	Taiyo Yuden LMK107BJ474KA
11	0	D1,D2,D3,D4 (Opt)	Schottky Diode, UPS5817	Microsemi UPS5817
12	3	JP1,JP2,JP4	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
13	1	JP3	Headers, Commcon2802s04g2	Comm-Conn. 2802S-04G2
14	1	J1	BNC Connector	Connex 112404
15	1	J2	Test Jacks, Shielded	Johnson Components 129-0701-201
16	4	L1,L2,L3,L4	Inductor, 2.7uH	TDK RLF5018T-2R7M1R8
17	0	Q1 (Opt)	P-Channel, 20V	ZETEX ZXM61P02F
18	1	RB1	Res., Chip 30.1K 0.06W 1%	AAC CR05-3012FM
19	1	RILIM1	Res., Chip 69.8K 0.06W 1%	AAC CR05-6982FM
20	1	RT1	Res., Chip 15K 0.06W 1%	AAC CR05-1502FM
21	3	R1,R3,R6	Res., Chip 1.0M 1/16W 5%	AAC CR05-105JM
22	2	R5,R2	Res., Chip 10K 0.06W 5%	AAC CR05-103JM
23	1	R4	Res., Chip 1M 1/16W 1%	AAC CR05-1004FM
24	1	R7	Res., Chip 100K 0.06W 5%	AAC CR05-104JM
25	1	R8	Res., Chip 590K 0.06W 1%	AAC CR05-5903FM
26	1	R9	Res., Chip 200K 0.06W 5%	AAC CR05-204JM
27	0	R10 (Opt)	Res., Chip 51 0.06W 5%	AAC CR05-510JM
28	4	TP1,TP2,TP6,TP7	Turret, Testpoint	Mill Max 2501-2
29	4	TP4,TP5,TP8,TP9	Turret, Testpoint	Mill-Max 2308-2
30	1	U1	I.C., Polyphase Switching Reg.	Linear Tech. Corp. LTC3425EUH


U2
LTC3425EUH
Linear Technology Corp.
1630 McCarthy Blvd., Milpitas, CA
95035-7417
Phone: (408)432-1900 Fax: (408)434-0507
Friday, October 03, 2003
4MHz, Polyphase™ Low Cost Synchronous Boost Converter
DEMO CIRCUIT 616A
PCB Layout
1V-3Vin
2V minimum for full
load current.

Vin=1V to 3V

Vout=3.3V@1.8A

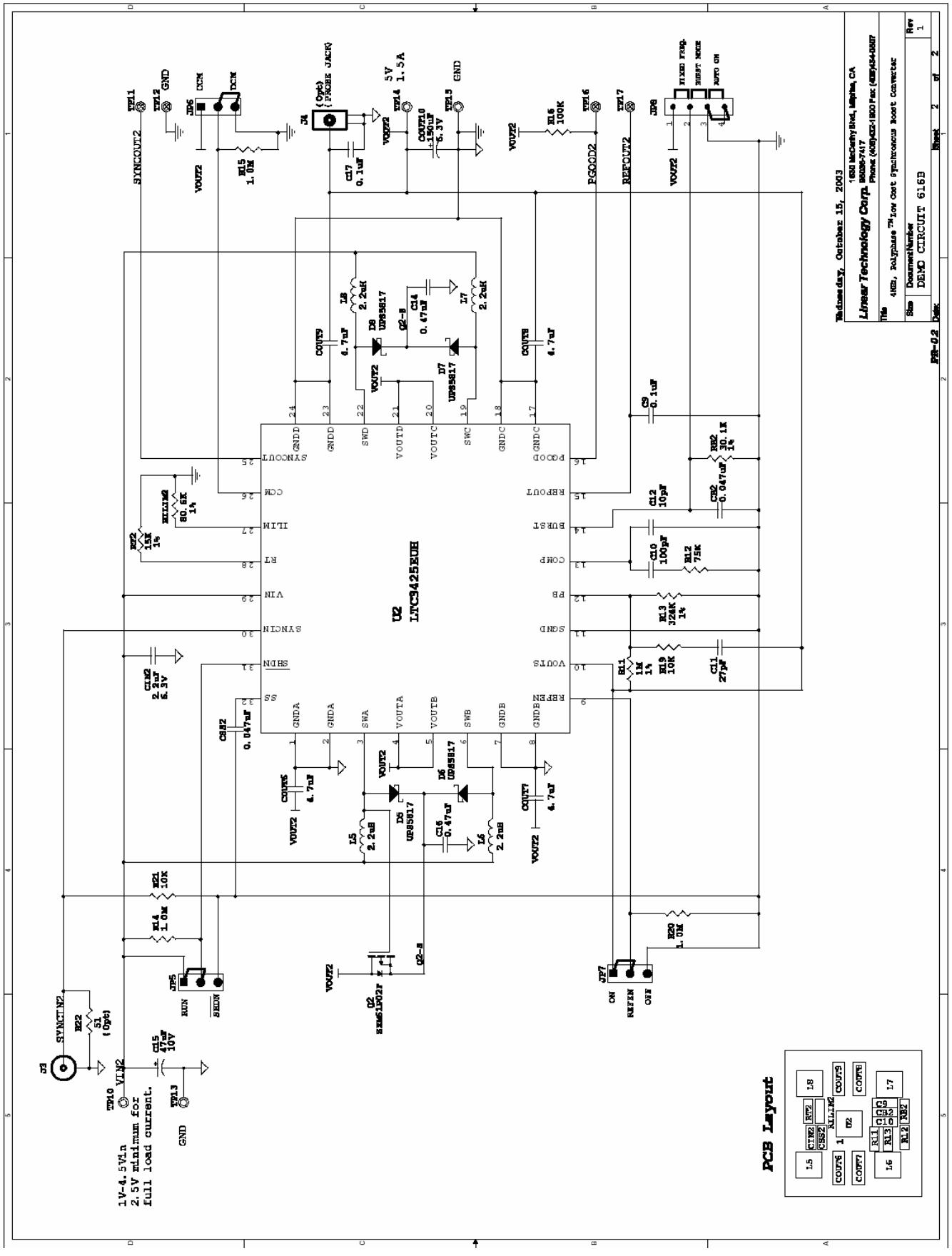
Item	Quantity	Reference	Part	
1	2	CSS2,CB2	Cap., X5R 0.047uF 16V 20%	AVX 0402YD473MAT2A
2	1	CIN2	Cap., X5R 2.2uF 6.3V 10%	Taiyo Yuden JMK107BJ225KA-T
3	4	COUT6,COUT7,COUT8,COUT9	Cap., X5R 4.7uF 6.3V 20%	Taiyo Yuden JMK212BJ475MG-T
4	1	COUT10	Cap., POSCAP 220uF 4V 20%	SANYO 4TPC220M
5	2	C17,C9	Cap., X5R 0.1uF 10V 10%	TDK C1005X5R1A104K
6	1	C10	Cap., NPO 220pF 25V 10%	AVX 04023A221KAT2A
7	1	C11	Cap., NPO 18pF 25V 10%	AVX 04023A180KAT2A
8	1	C12	Cap., NPO 10pF 25V 10%	AVX 04023A100KAT2A
9	0	C16,C14 (Opt)	Cap., X5R 0.47uF 10V 10%	Taiyo Yuden LMK107BJ474KA
10	1	C15	Cap., Tant. 47uF 10V 20%	AVX TAJB476M010
11	4	D5,D6,D7,D8 (Opt)	Schottky Diode, UPS5817	Microsemi UPS5817
12	3	JP5,JP6,JP7	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
13	1	JP8	Headers, Commcon2802s04g2	Comm-Conn. 2802S-04G2
14	1	J3	BNC Connector	Connex 112404
15	0	J4 (Opt)	Test Jacks, Shielded	Johnson Components 129-0701-201
16	4	L5,L6,L7,L8	Inductor, 2.2uH	muRata LQH32CN2R2M53
17	0	Q2 (Opt)	P-Channel, 20V	ZETEX ZXM61P02F
18	1	RB2	Res., Chip 30.1K 0.06W 1%	AAC CR05-3012FM
19	1	RILIM2	Res., Chip 80.6K 0.06W 1%	AAC CR10-8062FM
20	1	RT2	Res., Chip 15K 0.06W 1%	AAC CR05-1502FM
21	1	R11	Res., Chip 1M 1/16W 1%	AAC CR05-1004FM
22	1	R12	Res., Chip 200K 0.06W 5%	AAC CR05-204JM
23	1	R13	Res., Chip 590K 0.06W 1%	AAC CR05-5903FM
24	3	R14,R15,R20	Res., Chip 1.0M 1/16W 5%	AAC CR05-105JM
25	1	R16	Res., Chip 100K 0.06W 5%	AAC CR05-104JM
26	2	R21,R19	Res., Chip 10K 0.06W 5%	AAC CR05-103JM
27	0	R22 (Opt)	Res., Chip 51 0.06W 5%	AAC CR05-510JM
28	4	TP10,TP13,TP14,TP15	Turret, Testpoint	Mill Max 2501-2
29	4	TP11,TP12,TP16,TP17	Turret, Testpoint	Mill-Max 2308-2
30	1	U2	I.C., Polyphase Switching Reg.	Linear Tech. Corp. LTC3425EUH


U1
LTC3425EUH
1V-4.5Vin
2.5V minimum for
full load current.
PCB Layout

Vin=2.5V to 4.5V

Vout=5V@2A

Item	Quantity	Reference	Part	
1	2	CB1,CSS1	Cap., X5R 0.047uF 16V 20%	AVX 0402YD473MAT2A
2	1	CIN1	Cap., X5R 2.2uF 6.3V 10%	Taiyo Yuden JMK107BJ225KA-T
3	4	COUT1,COUT2,COUT3,COUT4	Cap., X5R 4.7uF 6.3V 20%	Taiyo Yuden JMK212BJ475MG-T
4	1	COUT5	Cap., POSCAP 150uF 6.3V 20%	SANYO 6TPC150M
5	1	C1	Cap., NPO 100pF 25V 10%	AVX 04023A101KAT2A
6	2	C8,C2	Cap., X5R 0.1uF 10V 10%	TDK C1005X5R1A104K
7	1	C3	Cap., NPO 10pF 25V 10%	AVX 04023A100KAT2A
8	1	C4	Cap., NPO 27pF 25V 10%	AVX 04023A270KAT2A
9	1	C5	Cap., Tant. 47uF 10V 20%	AVX TAJB476M010
10	2	C6,C7	Cap., X5R 0.47uF 10V 10%	Taiyo Yuden LMK107BJ474KA
11	4	D1,D2,D3,D4	Schottky Diode, UPS5817	Microsemi UPS5817
12	3	JP1,JP2,JP4	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
13	1	JP3	Headers, Commcon2802s04g2	Comm-Conn. 2802S-04G2
14	1	J1	BNC Connector	Connex 112404
15	1	J2	Test Jacks, Shielded	Johnson Components 129-0701-201
16	4	L1,L2,L3,L4	Inductor, 2.7uH	TDK RLF5018T-2R7M1R8
17	1	Q1	P-Channel, 20V	ZETEX ZXM61P02F
18	1	RB1	Res., Chip 30.1K 0.06W 1%	AAC CR05-3012FM
19	1	RILIM1	Res., Chip 69.8K 0.06W 1%	AAC CR05-6982FM
20	1	RT1	Res., Chip 15K 0.06W 1%	AAC CR05-1502FM
21	3	R1,R3,R6	Res., Chip 1.0M 1/16W 5%	AAC CR05-105JM
22	2	R5,R2	Res., Chip 10K 0.06W 5%	AAC CR05-103JM
23	1	R4	Res., Chip 1M 1/16W 1%	TAD CR05-1004FM
24	2	R7,R9	Res., Chip 100K 0.06W 5%	AAC CR05-104JM
25	1	R8	Res., Chip 324K 1/16W 1%	AAC CR05-3243FM
26	0	R10 (Opt)	Res., Chip 51 0.06W 5%	AAC CR05-510JM
27	4	TP1,TP2,TP6,TP7	Turret, Testpoint	Mill Max 2501-2
28	4	TP4,TP5,TP8,TP9	Turret, Testpoint	Mill-Max 2308-2
29	1	U1	I.C., Polyphase Switching Reg.	Linear Tech. Corp. LTC3425EUH


U2
LTC3425EUH
Wednesday, October 15, 2003
Linear Technology Corp.
1630 McCarthy Blvd., Milpitas, CA
Phone (408)432-1900 Fax (408)434-0507
Title
4MHz, Polyphase™ Low Cost Synchronous Boost Converter
Size
DemoCircuit
DEMO CIRCUIT 616B
Rev
1
Sheet 2 of 2
PCB Layout
1V-4.5V in
2.5V minimum for
full load current.

Vin=2.5V to 4.5V

Vout=5V@1.5A

Item	Quantity	Reference	Part	
1	2	CB2,CSS2	Cap., X5R 0.047uF 16V 20%	AVX 0402YD473MAT2A
2	1	CIN2	Cap., X5R 2.2uF 6.3V 10%	Taiyo Yuden JMK107BJ225KA-T
3	4	COUT6,COUT7,COUT8,COUT9	Cap., X5R 4.7uF 6.3V 20%	Taiyo Yuden JMK212BJ475MG-T
4	1	COUT10	Cap., POSCAP 150uF 6.3V 20%	SANYO 6TPC150M
5	2	C17,C9	Cap., X5R 0.1uF 10V 10%	TDK C1005X5R1A104K
6	1	C10	Cap., NPO 100pF 25V 10%	AVX 04023A101KAT2A
7	1	C11	Cap., NPO 27pF 25V 10%	AVX 04023A270KAT2A
8	1	C12	Cap., NPO 10pF 25V 10%	AVX 04023A100KAT2A
9	2	C14,C16	Cap., X5R 0.47uF 10V 10%	Taiyo Yuden LMK107BJ474KA
10	1	C15	Cap., Tant. 47uF 10V 20%	AVX TAJB476M010
11	4	D5,D6,D7,D8	Schottky Diode, UPS5817	Microsemi UPS5817
12	3	JP5,JP6,JP7	Headers, 3 Pins 2mm Ctrs.	CommConn Con Inc. 2802S-03G2
13	1	JP8	Headers, Commcon2802s04g2	Comm-Conn. 2802S-04G2
14	1	J3	BNC Connector	Connex 112404
15	0	J4 (Opt)	Test Jacks, Shielded	Johnson Components 129-0701-201
16	4	L5,L6,L7,L8	Inductor, 2.2uH	muRata LQH32CN2R2M53
17	1	Q2	P-Channel, 20V	ZETEX ZXM61P02F
18	1	RB2	Res., Chip 30.1K 0.06W 1%	AAC CR05-3012FM
19	1	RILIM2	Res., Chip 80.6K 1/16W 1%	AAC CR05-8062FM
20	1	RT2	Res., Chip 15K 0.06W 1%	AAC CR05-1502FM
21	1	R11	Res., Chip 1M 1/16W 1%	AAC CR05-1004FM
22	1	R12	Res., Chip 75K 0.06W 5%	AAC CR05-753JM
23	1	R13	Res., Chip 324K 1/16W 1%	AAC CR05-3243FM
24	3	R14,R15,R20	Res., Chip 1.0M 1/16W 5%	AAC CR05-105JM
25	1	R16	Res., Chip 100K 0.06W 5%	AAC CR05-104JM
26	2	R21,R19	Res., Chip 10K 0.06W 5%	AAC CR05-103JM
27	0	R22 (Opt)	Res., Chip 51 0.06W 5%	AAC CR05-510JM
28	4	TP10,TP13,TP14,TP15	Turret, Testpoint	Mill Max 2501-2
29	4	TP11,TP12,TP16,TP17	Turret, Testpoint	Mill-Max 2308-2
30	1	U2	I.C., Polyphase Switching Reg.	Linear Tech. Corp. LTC3425EUH